BUREAU OF SUGAR EXPERIMENT STATIONS

BRISBANE

QUEENSLAND, AUSTRALIA

TECHNICAL COMMUNICATIONS.

YEAR 1961, No. 6

Studies with Chlorotic Streak Disease of Sugar Cane
IV. Field Spread in Drainage Waters

by

B. T. EGAN

Issued by Direction of the Sugar
Experiment Stations Board

21 MAR 1962

Sugar Experiment Stations Board.

THE HON. O. O. MADSEN, M.L.A., Minister for Agriculture and Forestry, Chairman.
DR. W. A. T. SUMMERVILLE, Deputy Chairman.
MR. J. W. INVERARITY, Member.
MR. A. G. MANN, Cane Grower, Member.

Bureau of Sugar Experiment Stations.

N. J. KING, Director.
L. G. VALLANCE, Asst. Director.
R. W. MUNGOMERY, Asst. to Director.

Head Office Staff.

J. H. NICKLIN, Chief Technologist (Engr.).
C. G. HUGHES, Senior Pathologist (I).
D. R. L. STEINDL, Senior Pathologist (I).
L. R. BRAIN, Senior Mill Technologist (II).
H. E. YOUNG, Senior Physiologist (II).
O. W. STURGESS, Research Pathologist.
K. C. LEVERINGTON, Research Chemist.
R. F. BEALE, Engineer Technologist.
A. D. DOOLAN, Laboratory Technologist.
J. M. SEDL, Chemist.
J. R. BURGE, Analyst.
C. C. HORNE, Secretary.
A. D. BEAL, Asst. Accountant.
S. C. LEDDY, Records Clerk.
T. J. GIBSON, Clerk.
MISS F. M. DOOLAN, Librarian.
MISS P. SOUTHWICK, Clerk.
C. D. JONES, Cadet.
MISS J. E. MURPHY, Clerk-Typiste.
MISS M. P. LYNCH, Clerk-Typiste.
MISS D. L. HOLMES, Clerk-Typiste.
F. SHORT, Sen. Lab. Attendant.

Country Staff.

Meringa. Address: P.O. Box 122, Gordonvale; Phone: Gordonvale 95.

J. H. BUZACOTT, Senior Plant Breeder (I).
G. WILSON, Senior Entomologist (I).
J. C. SKINNER, Senior Geneticist (I).
B. T. EGAN, Pathologist.
B. E. HITCHCOCK, Entomologist.
G. BATES, Senior Adviser.
A. G. BARRIE, Agronomist.
C. A. REHBEIN, Senior Adviser.
N. G. GRAFF, Technical Officer (I).
F. C. LINDSAY, Technical Officer (I).
G. H. WHITAKER, Adviser
C. C. CORKILL, Technical Officer (II).
MISS N. J. SMITH, Clerk-Typiste.
MISS M. BARBER, Clerk-Typiste.
G. R. STROUD, Lab. Attendant.

Innisfail. Address: P.O. Box 630, Innisfail; Phone: Innisfail 271.

S. O. SKINNER, Senior Adviser.
I. T. FRESHWATER, Adviser.

Ingham. Address: P.O. Box 41, Ingham; Phone: Ingham, 500.

O. W. D. MYATT, Senior Adviser.
I. J. V. STEWART, Field Assistant.

Ayr. Address: P.O. Box 28, Brandon; Phone: Brandon 45.

G. A. CHRISTIE, Senior Adviser.
L. S. CHAPMAN, Senior Adviser.
J. WESDORP, Asst. Agronomist.
J. A. HUCKNALL, Field Assistant.
MISS B. L. LENNOX, Clerk-Typiste.

Mackay. Address: P.O. Box 280, Mackay; Phone: Mackay 2717.

G. C. BIESKE, Research Chemist.
C. G. STORY, Senior Adviser.
A. A. MATTHEWS, Senior Adviser.
E. A. PEMBROKE, Senior Adviser.
C. M. MCALEESE, Adviser
C. E. GLOVER, Field Assistant.
MISS J. L. CRONIN, Clerk-Typiste.
MISS C. HARVISON, Clerk-Typiste.
R. E. KERKWYK, Lab. Attendant.

Bundaberg. Address: P.O. Box 516, Bundaberg; Phone: Woongarra 228.

B. G. ADKINS, Research Mill Technologist.
A. G. CLAIRE, Mill Technologist.
R. B. MOLLER, Agronomist.
H. G. KNUST, Senior Adviser.
N. MCD. SMITH, Senior Adviser.
E. D. JENSEN, Laboratory Technologist.
P. N. STEWART, Asst. Mill Technologist.
R. K. HILHORST, Technical Officer (I)
P. G. ARNOLD, Field Assistant.
MISS J. PRIEBE, Clerk-Typiste.

Childers. Address: P.O. Box 2, Childers; Phone: Childers 32.

J. ANDERSON, Adviser.

Nambour. Address: P.O. Box 139, Nambour; Phone: Nambour 668. (Office: 684).

C. L. TOOHEY, Senior Adviser.

BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE
QUEENSLAND, AUSTRALIA

TECHNICAL COMMUNICATIONS.

YEAR 1961, No. 6

Studies with Chlorotic Streak Disease of Sugar Cane
IV. Field Spread in Drainage Waters

by

B. T. EGAN

Issued by Direction of the Sugar
Experiment Stations Board

STUDIES WITH CHLOROTIC STREAK DISEASE OF SUGAR CANE

SUMMARY

The presence of the chlorotic streak disease pathogen was demonstrated in water taken from drainage ditches on farms where the disease was endemic. That such water may remain infective for several days was indicated in another experiment where nutrient solution remained infective for at least seven days after it was removed from contact with diseased plants.

Studies with Chlorotic Streak Disease of Sugar Cane

IV. Field Spread in Drainage Water

By B. T. EGAN

INTRODUCTION

The general association of chlorotic streak disease with soils which may be waterlogged for considerable periods was realized soon after chlorotic streak was recognized as a distinct disease some thirty years ago. The wetter parts of fields were inevitably the more heavily infected and, in many instances, the spread of disease from an initial focus indicated a water-borne dispersal of the pathogen.

The idea that the causal agent of chlorotic streak might be directly associated with waters occurring where the disease was common was first put forward by Martin in 1940 [6]. He reported transmissions by inoculation of both ditch and surface waters into the region of the growing point of plants maintained in complete aerated nutrient solutions. Since that time several workers have published results which are of importance in any consideration of the spread of the disease per medium of free water. Bird *et alia* [2] in Peurto Rico and Sturgess [7] in Queensland have shown that direct contact between plants is not necessary for transmission, i.e., the nutrient solution itself can act as a carrier for the pathogen. Results obtained by Antoine [1] in drums of soil suggest that the leachate from diseased stools growing in "diseased" soil is infective. Subsequently, it was reported [3] that leachates from diseased stools growing in either diseased or steam-sterilized soil were infective.

The decision to test the infectivity of ditch water at the Northern Experiment Station near Gordonvale, North Queensland, was influenced by its proximity to the wettest section of the Queensland sugar belt. There the mountains which rise up to 5,000 feet above the canefields on the coastal plain, produce an average rainfall in excess of 150 inches. Chlorotic streak is endemic and serious in the more low-lying areas and drainage ditches run strongly for the greater part of the year.

Success with transmission per medium of the ditch water lead to a preliminary trial to test the longevity of the pathogen in water which had drained from experimental nutrient gravel troughs in other experiments at the station.

MATERIALS AND METHODS

The equipment and general set-up used in the main experiments (No. I, II and III) were described by Egan [4] in a previous communication in this series. The only changes in technique have been to eliminate the black polythene covering of the troughs since it was found unnecessary, and to add "Metasystox" (50 per cent. w/w active ingredient) to the nutrient solution at approximately monthly intervals at the rate of 50 p.p.m. of active ingredient; this ensured virtual freedom from insect and mite infestation.

The ditch drainage waters used were obtained from low-lying farms in the Fishery Falls section of the Babinda mill area, where the disease is endemic. These ditches drain fields which show a high incidence of chlorotic streak; the main ones run permanently, although the water flow is greatly restricted in the dry season. Where possible, the water was collected from side drains and as near as practicable to heavily chlorotic streaked cane. The water was transported back to the Experiment Station in drums.

The troughs of healthy cane were serviced with this water with a minimum of delay, the maximum elapsed time from ditch to trough being five hours although the average would be less than three hours. Each trough therefore received up to 60 litres of ditch water at weekly intervals when the nutrient solution changes were made. In general, any topping-up of water levels during this weekly period was done with the reticulated, town-water supply. This was also used to service the experiments when the use of ditch water was discontinued.

In the experiment (No. IV) to test the longevity of the pathogen in stored drainage water, the test plants were grown in two-gallon steel containers painted with a bitumastic-based aluminium paint. These were filled with sterilized gravel and could be drained by means of a plug hole near the base; each contained three healthy cane plants. The containers were serviced at weekly intervals with the appropriate stored water, while any interim topping-up of water levels was done with the town-water supply. The water used in this experiment was drained off at weekly intervals from three troughs in which chlorotic streak diseased stools were growing. These were in fact the troughs used in the Experimental Series III of a previous communication (Egan [4]), and transmissions were being recorded in them at that time. The drainage waters were bulked, stored under cool shady conditions in $12\frac{1}{2}$ gallon drums adequately protected by a bitumastic-based aluminium paint, and used as required.

The varieties of cane used in one or other of the experiments were Badila, E.1/37, H.32-8560, N.Co.310, Q.66, Q.67 and Vidar. These were obtained from presumably disease-free blocks on the Northern Sugar Experiment Station, and were hot-water treated at 52°C. for 30 minutes before planting in flats of sand. These varieties are all susceptible or highly susceptible to chlorotic streak and show prominent leaf streaks when infected.

Experiment I

Planted 3rd August, 1959, concluded 17th June, 1960. Thirty-two healthy cane shoots of the varieties Badila, N.Co.310, Q.66, Q.67 and Vidar were planted in each of two troughs. One trough (designated A) was serviced with ditch water at approximately weekly intervals from 3rd August to 21st December, 1959, while the other acted as control. One third of the stools in each trough were ratooned on 30th October and the remainder on 21st December, 1959, while all stools were ratooned again on 5th May, 1960.

Experiment II

Planted 5th April, 1960, concluded 12th December, 1960. Thirty-five healthy cane shoots of the varieties N.Co.310, Q.67 and Vidar were planted in each of three

troughs. One trough was kept as a control while the other two (designated B and C) were serviced with ditch water at approximately weekly intervals from 26th April to 12th August, 1960. One-third of the shoots in each trough were ratooned on 15th July, another one-third on 7th September, and the remaining one-third on 18th October; the early ratoons were again ratooned on 11th November, 1960.

Experiment III

Planted 7th January, 1961, concluded 13th September, 1961. Thirty-five healthy cane shoots of the varieties E.1/37, H.32-8560, N.Co.310 and Q.67 were planted in each of three troughs. One trough was kept as a control while the other two (designated D and E) were serviced with ditch water at approximately weekly intervals from 20th January to 16th June, 1961. One-half of the shoots in each trough were ratooned on 10th April and the remainder on 4th May, while all shoots were again ratooned on 28th July, 1961.

Experiment IV

Planted 15th July, 1960, concluded 4th May, 1961. Two shoots of N.Co.310 and one of Q.67 were planted in each two-gallon container. Treatments comprised water stored for 0, 3½, 7 and 14 days, plus healthy control, and consisted of eight containers each. Treatment was commenced on 29th July and concluded on 16th December, 1960. Each treatment was given at weekly intervals for 20 weeks in the case of the 0, 3½ and 7 days' storage series, but for only 13 weeks in the case of the 14 days' storage series. Half the containers in each series were ratooned on 7th October and the remainder on 10th November, 1960. The former were again ratooned on 23rd December, 1960 and the latter on 20th January, 1961.

RESULTS

Experiments I, II, III

Growth, stooling and ratooning were very good in all cases. Those troughs receiving ditch water were slighly but consistently superior to the controls, indicating that they were receiving some extra benefit from the water. Table I shows the results obtained in the troughs under test. All control troughs remained healthy.

TABLE I

Chlorotic streak transmissions obtained in troughs receiving ditch water.

Days after treatment commenced	Trough					Symptoms
	A	B	C	D	E	
105				1		moderate to poor
106			1			good
111		1				moderate to poor
115			1			poor
136		1				poor
164		1	1			poor
210					1	vague
213		1				poor
Total diseased	0	4	3	1	1	
% diseased	0	11	9	3	3	

Disease symptoms were generally poor and only a stool of Vidar (106 days) in Trough C showed abundant and typical streaking. In the others, the streaks were usually few in number, of short length and low colour intensity, while necrosis rarely occurred. Some stools also appeared to recover from the disease, while symptoms in the subsequent ratoons tended to be poorer than in the plant crop. In contrast, the new transmissions showed abundant and typical streaking in some adjacent troughs originally planted with healthy and diseased shoots.

Experiment IV

Growth was comparatively good in the two-gallon containers, while stooling and ratooning were excellent. However, the plants suffered at times due to excessive hydrogen sulphide production in the water during the storage period. This was particularly true of the 14 days' treatment but the seven days' treatment was also affected. The position became so bad that the 14 days' storage series was no longer serviced with stored water after the thirteenth week.

In Table II, the numbers of replicate containers which had contracted chlorotic streak disease are recorded against the time delay after treatments were initiated. Although there were three stools of cane per container, it was not possible to give the true percentage disease in these since secondary infection within the container was quite feasible. In addition, containers were discarded from the experiment within a few weeks of contracting the disease. Despite these restrictions, collated results to 3rd February, 1961. i.e. the 189 day period, showed the percentage of stools diseased in the 0, 3½ and 7 days' series to be 70 per cent., 8 per cent. and 33 per cent. respectively, while the last two figures had advanced to 33 per cent. and 66 per cent. in the final count at 275 days.

Symptoms were excellent in the nil storage series, but varied from poor to excellent in the other two series.

TABLE II

Containers contracting chlorotic streak disease when supplied with stored drainage water: eight containers per series.

Days after treatments commenced	Storage period			
	0 days	3½ days	7 days	14 days
91	1			
105	2			
119	1			
140	2		1	
147	1			
150		1		
182			4	
189	1			
275*		3	3	
Percentage containers with disease	100	50	100	—

*No observations were made during the 189 to 275 day period.

DISCUSSION

The results reported herein demonstrate that chlorotic streak infection potential does exist in drainage water from areas where the disease is endemic. The small number of transmissions obtained—nil, 10 per cent. and 3 per cent. in Experiments I, II and III respectively—indicated that the concentration of the pathogen in the water was quite low.

This point is of considerable practical importance, and it is probable that the potential varies with weather conditions and the source of the drainage water. All three experiments utilized the same set of ditches as water sources, while heavily diseased stools of Pindar plant or ratoon cane were present in the fields throughout the period when water was collected. However, weather conditions differed in each case.

The water for Experiment I was collected in the spring and early summer of 1959, which coincided with the dry season. Rainfall was light during the period and the ditches were flowing poorly; most of the water collected would have been sub-surface drainage or from springs. For Experiment II, the collection period was autumn and winter of 1960, i.e. at the end of the wet season. All ditches were flowing strongly, and the rainfall, although light to moderate, did result in some surface run-off. For Experiment III, the collection period was summer and autumn

Figure 1 — Collecting ditch water

of 1961, i.e. during what is normally the rainy season. Unfortunately, this was far below average while the preceding six months had been droughty. Consequently, the ditches flowed at a lower than normal level, while surface run-off was relatively slight. Figure 1 shows a typical collection point.

When the transmission results are considered in the light of this information, the role of surface run-off in chlorotic streak dispersal takes on some significance.

A somewhat puzzling feature is the negligible rate of secondary transmission within the troughs. For Troughs B and C, the transmissions recorded at 164 and 213 days were possibly secondary; these three stools were ratoons and they would fit into the normal pattern of ratoon transmission of the disease. However, a normal pattern would result in a greater than 50 per cent. transmission rate over such a period if a diseased stool showing good symptoms was planted into a trough of healthy cane. At least Trough C seemed to fulfil these requirements yet the results were poor. Also, in Trough D the single transmission recorded at 105 days showed sufficient streaks to indicate that it could act as a source of chlorotic streak infection; yet no transmissions occurred.

It is therefore postulated that, where an infection is initiated by very low concentrations of the pathogen, a period of build-up must occur in the diseased plant before it is capable of releasing any infective material itself. This theory is consistent with the pattern of field spread in certain previously healthy districts in Queensland [5]. Only a few diseased stools were located initially in these areas, despite intensive surveys, yet some 12 months later the disease was widespread.

If water plays an important part in intra-district spread of chlorotic streak disease, it must remain infective for at least a few days. The results produced in Table II show that, if a presumably strong concentration of the pathogen is used, water will remain infective for at least seven days. Unfortunately, the excessive hydrogen sulphide formation during the storage period, and the shortened period of treatment, rendered the negative results obtained in the 14 days' series of little use. Indeed, the results from the shorter treatments seemed to indicate that the water would remain infective for a longer period still.

Of interest is the extended incubation period of chlorotic streak in the stored waters compared with the water used immediately—140 or 150 days for the former compared with 91 days for the latter. The rate of infection was also much slower in the stored waters—30 days after the initial transmission in each series, no further transmissions had been recorded in the $3\frac{1}{2}$ and 7 day series, while the total had risen to 50 per cent. in the water used immediately.

From these figures, it would seem that quite a proportion of the infective principle became inactivated during the early part of the storage period, but more than enough remained to ensure transmission.

Admittedly the chlorotic streak potential of the water used was very much higher than that expected to occur in drainage ditch waters, so that the results cannot be compared quantitatively with those obtained in the previous experiments.

Nevertheless, they do show that the pathogen is not unstable in trough drainage water and it may be inferred that, under certain conditions, natural drainage waters also could remain infective for periods of at least a few days.

ACKNOWLEDGMENT

My thanks are due to Mr. N. G. Graff, Technical Officer, for the considerable help received in setting up and servicing these experiments, especially in the collection of drainage ditch waters.

REFERENCES

1 Antoine, R. (1959).—Studies on chlorotic streak disease of sugar cane. Proc. Int. Soc. Sugar Cane Tech. 10th Cong. 1091-1097.

2 Bird, J., Cibes, H. and Tio, M. A. (1958.)—Transmission of the causal agent of the chlorotic streak disease of sugar cane through the roots of plants grown in nutrient solution. Uni. Puerto Rico Agric. Exp. Sta., Tech. Paper No. 27.

3 Bur. Sug. Exp. Stas. Qd. (1960).—Ann. Rept. 82

4 Egan, B. T. (1961).—Studies with chlorotic streak disease of sugar cane. II Transmission in nutrient gravel cultures. Bur. Sug. Exp. Stas., Qd. Tech. Comm., 1961, No. 4.

5 Hughes, C. G. (1957).—Ann. Rep. Bur. Sug. Exp. Stas., Qd. 85-86.

6 Martin, J. P. (1940).—Pathology. Haw. Sug. Planters' Assoc. Proc. 60th Ann. Meeting, 32.

7 Sturgess, O. W. (1960).—Studies with chlorotic streak disease of sugar cane. 1. Introductory nutrient solution studies. Bur. Sug. Exp. Stas., Qd. Tech. Comm., 1960, No. 3.

Watson, Fergu
and Compan
Brisbane